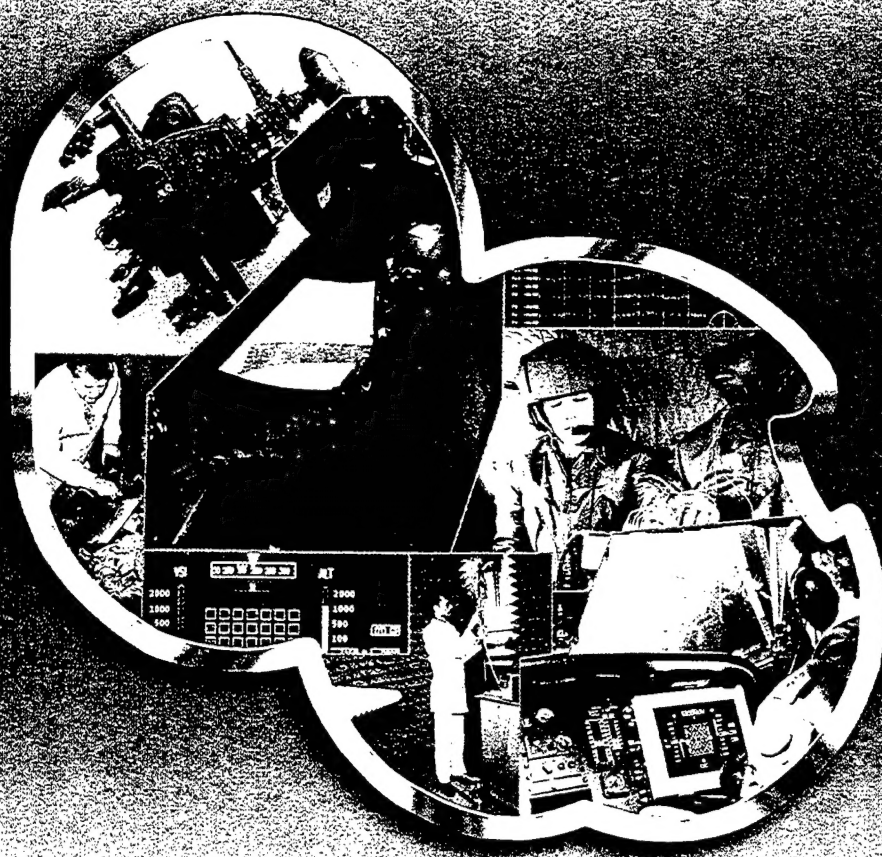


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A Comparison Study of Peripheral Vision-Restricting Devices Used for Instrument Training

by Arthur Estrada, Patricia A. LeDuc, Larry C. Woodrum, Teri L. Rowe, Elizabeth G. Stokes, and John S. Crowley



Aircrew Health and Performance Division

March 2005

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13. ABSTRACT (Maximum 200 words)

For decades, civilian and military flight instructors have used peripheral vision-restricting devices (PVRDs) in order to enhance instrument flight training that was performed during periods of visual conditions (outside of clouds). In addition to limiting a pilot's view only to the primary flight instruments, PVRDs also cause the artificial exclusion of the full cockpit environment, i.e., overhead switches and gauges, and those on the center and opposite-pilot side of the instrument panel. These restrictions and loss of peripheral information and spatial orientation can, and do, cause adverse physiological and psychological effects on some pilots. PVRDs must be worn in accordance with current directives regardless of any identified negative effects on training and proficiency.

This study attempted to identify the most preferred PVRD among three devices reportedly used by a survey population and a newly designed hood concept. When considering all of the data in aggregate, the Novel Hood was judged the most preferred based on performance ratings, minimal reports of adverse affects, and its selection as the first choice of one-half of the participants. The most preferred device among those readily available for use by aviators appears to be the visor sticker. The Foggles® received "worst" ratings in both the field of view and comfort categories. The hood was easily identifiable as the least favored. It received generally poor performance appraisals and caused a sizeable number of reported adverse effects, including loss of situational awareness and spatial disorientation. Its overall favorable ratings and demonstrated promise of minimizing the adverse effects associated with PVRD use during instrument flight training indicate its acceptability to the aviation community. It is also recommended that the U.S. Army issue the visor sticker as an interim "standard" for meeting the conditions set forth in all aircrew training manuals.

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Introduction

For decades, civilian and military flight instructors have used peripheral vision-restricting devices (PVRD) in order to enhance instrument flight training that was performed during periods of visual conditions (outside of clouds). During periods of instrument meteorological conditions, or IMC (basically, in clouds), PVRDs are not required because all visual references are naturally restricted to the aircraft cockpit. However, during visual conditions, pilots can easily refer to outside visual references for spatial orientation and navigational cues. Therefore, it has been the accepted practice to artificially restrict the pilot's view by using PVRDs. These devices allow the viewing of the aircraft flight instruments while effectively restricting the viewing of outside visual references. Theoretically, the use of PVRDs prepares pilots to fly in clouds or other conditions of limited visibility with reference to instruments only. However, in addition to limiting a pilot's view only to the primary flight instruments, PVRDs also cause the artificial exclusion of the full cockpit environment, i.e., overhead switches and gauges, and those on the center and opposite-pilot side of the instrument panel. These restrictions and loss of peripheral information and spatial orientation can cause adverse physiological and psychological effects in some pilots, such as uneasiness, despair, distraction, nausea, claustrophobia, loss of situational awareness and spatial disorientation as evidenced by a survey administered to 121 operational pilots (Appendix B and Estrada, 2005).

Background and military significance

The use of PVRDs in the U.S. Army is not voluntary. Most U. S. Army fixed and rotary-wing Aircrew Training Manuals (excluding those of the Apache and Kiowa aircraft) specifically require the use of a PVRD when performing an instrument task in VMC (visual meteorological conditions) as a condition of the task (Headquarters, Department of the Army, 1992a, 1992b, 1992c, 1992d, 1993a, 1993b, 1996a, and 1996b). In other words, the "conditions" under which each instrument maneuver must be trained and/or performed, under visual conditions (outside of the clouds), require a PVRD.

Therefore, PVRDs must be worn in accordance with current directives regardless of any identified negative effects on training and proficiency. To complicate the matter, the U.S. Army does not provide and has not established a standard device to use. Current practice is that aviation units use whatever device is available, acquired and/or preferred by their trainers. For example, commercially available hoods, and those in the government supply system (National Stock Number 8415-01-394-8453), are used and many are modified with night vision goggle mounts so that they snap onto a flight helmet's receiving mount. However, these hoods vary as to their fields of view (degrees) due to their different widths and lengths (the distance that they extend from the pilot's face). In addition, there are numerous commercially available glasses-type devices (glasses that are opaque except for a small area to view through such as Foggles® [Appendix H]) reportedly being used by units in the field. These are available in different tinted colors. Some instructor pilots prefer to use a plastic sheet (visor sticker) that adheres to the flight helmet visor which restricts the visual field similar to the Foggles®. These are inexpensive and easily stored. Probably the most disquieting (ingenious?) PVRD in use appears to be DA Forms

2408-12 or -13. These 7 x 8.5 inch forms (thick paper), available in an aircraft logbook is inserted into a slot above the helmet visor (between the visor and visor protector). Recent discussions with members of the US Army Directorate of Evaluation and Standardization confirmed that they are not aware of any effort to standardize a PVRD for the U.S. Army.

Based on the first author's experience (instructor pilot with over 5000 flight hours and twenty-five years of Army aviation flight experience), some PVRDs are more effective than others (providing training benefit while minimizing adverse affects). Multiple searches of scientific databases and the worldwide web produced no evidence of similar or directly-related research of PVRDs upon which predictions could be based as to which device is best to use. (See details of relevant literature and research review in Appendix G). In an unrelated study (involving similar *limited in-cockpit vision*) published by Wildzunas (1995) on the visual performance effects of an aviation chemical protective mask (thus, a reduction in pilot field of view similar to PVRD effects), degraded pilot performance while wearing the mask is reported. He writes:

...while [aviators] may not want to fly in a protective mask, when asked to do so, they can overcome the inherent task difficulties and perform their assigned duties. It is possible that these difficulties stemmed from decreases in the field-of-view (FOV) inherent with wearing protective masks. . . . The deflated performance scores for the [flight] maneuvers in the simulator also may be indicative of FOV problems.

Based on an apparent lack of research in this area, a user survey (Appendix A and Estrada, 2005) was distributed to 121 helicopter aviators (student pilots, instructor pilots and those attending helicopter instructor pilot courses at Ft. Rucker, Alabama). Many of these aviators were members of units stationed around the world on temporary duty at Fort Rucker and represented pilots qualified in all U.S. Army helicopter types. Specific demographics were not sought. The purpose of the survey was to achieve an understanding of the extent of peripheral vision-restricting device use and its effect (real and perceived) on training and proficiency. According to the results of the survey (Appendix B and Estrada, 2005), there is no standard device used by Army aviators, although six devices were identified as being used (hood, hood w/NVG mount, visor sticker, Foggles[®], a paper form and Jeppesen[®] Flip-up glasses [Appendix H]). Visits to pilot-supply stores and an internet search for PVRDs indicate that five of the six devices (minus the paper form) identified in the survey were representative of those commercially available (manufacturer variations were minor). Basically, there are three basic types: hoods, which extend outward from the forehead or helmet; partially frosted glasses (such as Foggles[®] and Jeppesen[®] Flip-up), which are worn on the face; and a plastic sheet, which is attached onto a helmet visor.

The findings indicated that PVRDs were used by 95% of those surveyed. The majority (61%) reported that they used a visor sticker. Of those who had a device preference, 18% *preferred* the visor sticker. Interestingly, 34% had no preference. Seventy-nine percent believed that a PVRD is important to instrument training and proficiency, and most (67%) believed the Army should issue a standardized device. The most revealing data collected by this user survey were those regarding negative effects. Although 40% of the respondents reported no negative

effects as a result of PVRD use, the majority (51%) reported the following effects: 18 reported uneasiness; 6 reported despair; 10, distraction; 7, nausea; 9, claustrophobia; 16, loss of situational awareness; 35, spatial disorientation; and 9 reported miscellaneous negative effects. Although 29 percent experienced these negative effects rarely, 18% experienced them occasionally, with 5 individuals experiencing them during each use.

In light of these data, it is presumed to be in the best interest of the Army and its aviators (and the civilian pilot community) to identify the most effective PVRD among those devices reportedly used by the survey population that will both enhance instrument flight training and minimize any negative effects.

The authors took the opportunity of this study to assess a Novel Hood (modified by USAARL researchers and engineers) and compare its performance against the standard devices described below. The Novel Hood is a modification to the already-modified (without any Army standardization) hood with NVG mount. A full description of the devices follows below.

Review of relevant literature and research

An extensive search for relevant literature and research (including works in progress) produced no indications of any previous studies regarding the effects of PVRDs. The searches did, however, produce many advertisements for such devices for sale. A detailed description of the literature review process is available in Appendix G.

Objective

The objective of the study was to identify user attitudes regarding the most preferred peripheral vision-restricting device among those devices reportedly used by a survey population (and a Novel Hood).

Methods

Subjects

Following completion of an informed consent form and a demographic questionnaire, 24 U. S. Army aviators (student pilots, instructor pilots and those attending instructor pilot courses) flew four 20-minute (approximate time) predetermined and pre-briefed instrument flights in the USAARL NUH60 flight simulator. These personnel were identified through local advertisement and solicitation.

Materials

Demographic questionnaire

The demographic questionnaire (Appendix F) was administered to each aviator prior to their first flight to collect anonymous demographic data.

Simulator

All flights were conducted in the USAARL NUH60 research flight simulator. This motion-based system includes an operational crew station (cockpit) and computer-generated visual displays in two forward-looking windshields and two side windows.

PVRDs

The findings of the user survey indicate that there were six devices reportedly used by aviators within the surveyed population. Of these six devices, two were not considered for testing in this study. The DA Forms 2408-12 or -13, a field-expedient solution, is a 7 x 8½-inch paper card, provides too much variability in fields of view because the fields of view are dependent on how far the card is pushed up into the visor protector. Additionally, its security on the helmet is not dependable, as it tends to fall easily during use. One respondent reported the use of Jeppesen® Flip-up glasses. They are very similar to the Foggles® described above, but are secured to the head by a headband. (Picture is unavailable.) Their similarity to the Foggles® and minimal use did not warrant their testing. The remaining four devices (the hood, Foggles®, visor sticker, and the Novel Hood) were assessed during this study. A brief description of each of the four devices follows.

Hood

The hood (Figure 1) used was the hood available through the government supply system (National Stock Number 8415-01-394-8453). Its cost per unit is \$52.40 and it is made of thin, semi-flexible plastic. It is made by the Gentex Corporation (Appendix H) and snaps onto the HGU-56/P helmet. (The HGU-56/P is the helmet worn by all Army aviators except AH-64 Apache pilots.)

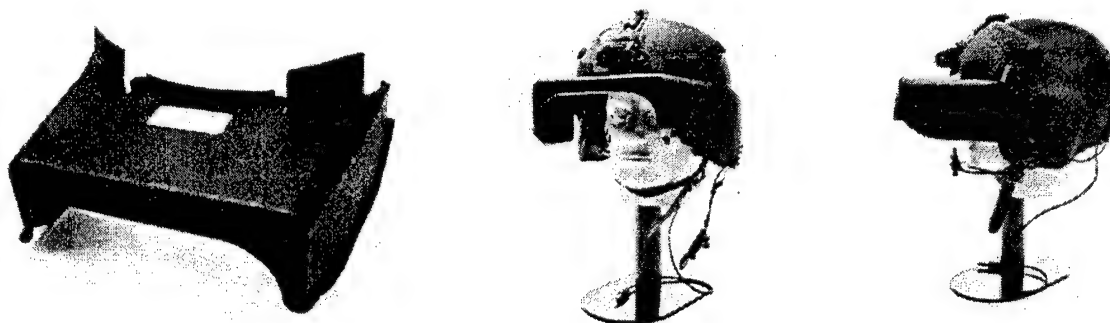


Figure 1. Hood.

Foggles®

The Foggles® (Figure 2) used were those used locally and available for \$24.95. Although available in different colors, white shading with clear lenses was selected for the study. It was decided that the clear lenses would be the most suitable for use in the research flight simulator.

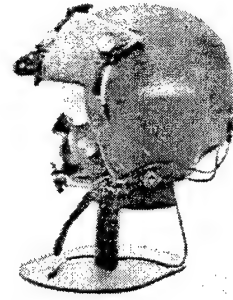
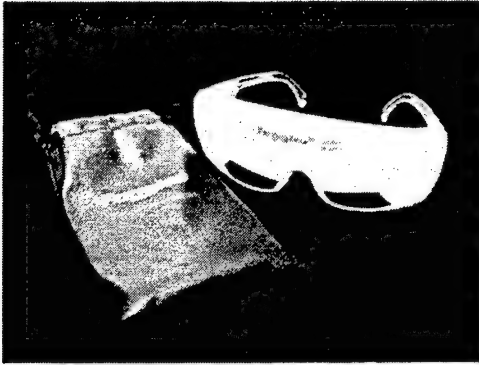


Figure 2. Foggles®.

Visor sticker

The visor sticker (Figure 3) used during the study was the device used by 61% of the surveyed population. The sticker was purchased locally for \$2.99.

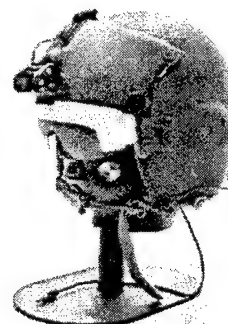
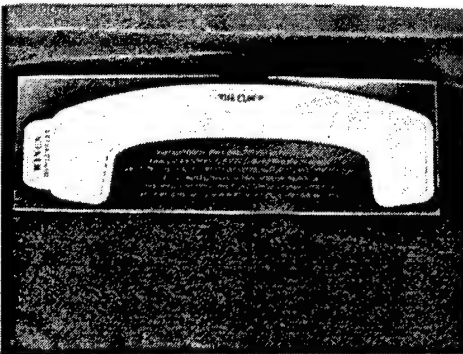


Figure 3. Visor sticker.

Novel Hood

The fourth device in this comparison was a further modification of a hood already modified with an NVG mount. This basic hood with NVG mount can be found in some aviation units and is the most variable in its modification. A search in the local aviation training community located several versions with nonstandardized lengths and widths. The authors used a novel approach with the basic government-supplied Gentex hood and attached an NVG mount (as

many have done before) and then added side "windows" to allow cockpit-side peripheral vision (Figure 4). In other words, a pilot seated on the left side of the aircraft and viewing his/her flight instruments can open the right "window" allowing a scan of aircraft *system* instruments and/or the center console. Opening this area for viewing may decrease some of the reported negative effects such as claustrophobia.

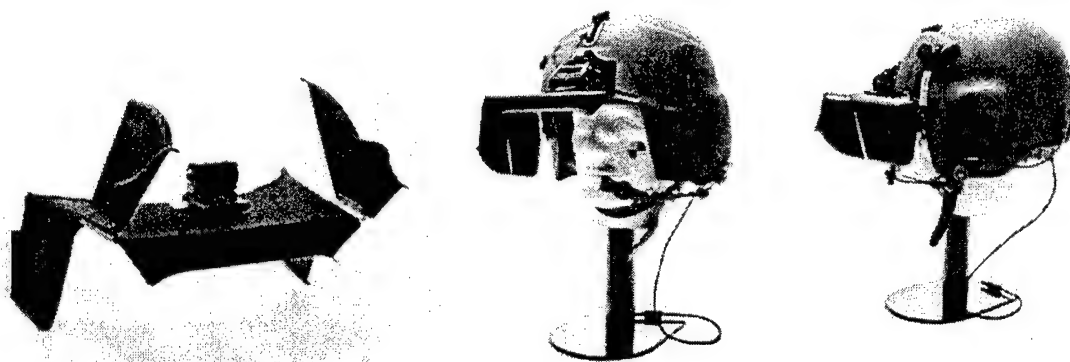


Figure 4. Novel Hood (note NVG mount and side windows)

Department of Defense Flight Information Publications

The participants were provided with copies of Volumes 14 and 16, Low Altitude United States, Instrument Approach and Departure Procedures, for reference during the conduct of the flights and instrument approaches (Appendix C).

Postflight questionnaire

A postflight questionnaire (Appendix E) was administered to every participating aviator after each flight to collect anonymous subjective data about each PVRD. The subject was asked to rate the device in regard to the: 1) field of view (considering whether the device was too restrictive, just right, or not restrictive enough), 2) comfort during flight (considering any discomfort or pain caused by the device), 3) size (considering whether its size was adequate to serve as an effective aid to instrument training), and 4) ease of use/application (considering the difficulty in donning and employing the device). The subject then was asked to what extent the use of the device caused any adverse physiological effects such as those reported in the user survey (Appendix A). They were specifically asked about any experiences of uneasiness, distraction, despair, claustrophobia, nausea, loss of situational awareness, spatial disorientation and any other experience not listed. The final question asked the participants to rate the devices in order of preference from 1 through 4, with 1 being the first (best) choice.

Procedures

In the USAARL NUH60 flight simulator, after receiving a premission briefing prior to the first flight (Appendix D), each participating aviator flew four 20-minute instrument flights (Appendix C), repeating the same route, under visual meteorological conditions while wearing a

different PVRD during each flight. Following each flight, the aviator completed a postflight questionnaire regarding the PVRD used during the flight. Following the fourth and final flight, the aviator rated the four PVRDs in order of preference. No feedback was provided to the participant until after their participation in the study was completely finished.

Note that due to an upgrade to the USAARL NUH60 Flight Simulator visual database during the data collection phase of this study, the instrument approach (Cairns Army Airfield ILS Runway 6) used for the first 9 subjects was no longer available. The remaining 15 subjects, following USAARL Scientific Review Committee approval, flew the Campbell Army Airfield ILS Runway 23 instrument approach. This change resulted in different flight headings and altitudes. Although the flight headings and altitudes differed, the procedures to conduct the flights and approaches were identical allowing the assessment of each PVRD while conducting, essentially, the same flight procedures.

A fully balanced design (Table 1) was used to minimize possible order effects of PVRD use.

Table 1.
Assessment order.

Subject 1	1	2	3	4
Subject 2	2	1	3	4
Subject 3	3	2	1	4
Subject 4	4	2	3	1
Subject 5	1	3	4	2
Subject 6	2	3	4	1
Subject 7	3	1	4	2
Subject 8	4	3	1	2
Subject 9	1	4	2	3
Subject 10	2	4	1	3
Subject 11	3	4	2	1
Subject 12	4	1	2	3
Subject 13	1	2	4	3
Subject 14	2	1	4	3
Subject 15	3	2	4	1
Subject 16	4	2	1	3
Subject 17	1	3	2	4
Subject 18	2	3	1	4
Subject 19	3	1	2	4
Subject 20	4	3	2	1
Subject 21	1	4	3	2
Subject 22	2	4	3	1
Subject 23	3	4	1	2
Subject 24	4	1	3	2

1 = Hood, 2 = Novel Hood, 3 = Foggles®, 4 = Visor sticker

Results

Demographic survey

Positions and jobs

Figure 5 illustrates the distribution of the subjects' current position or job.

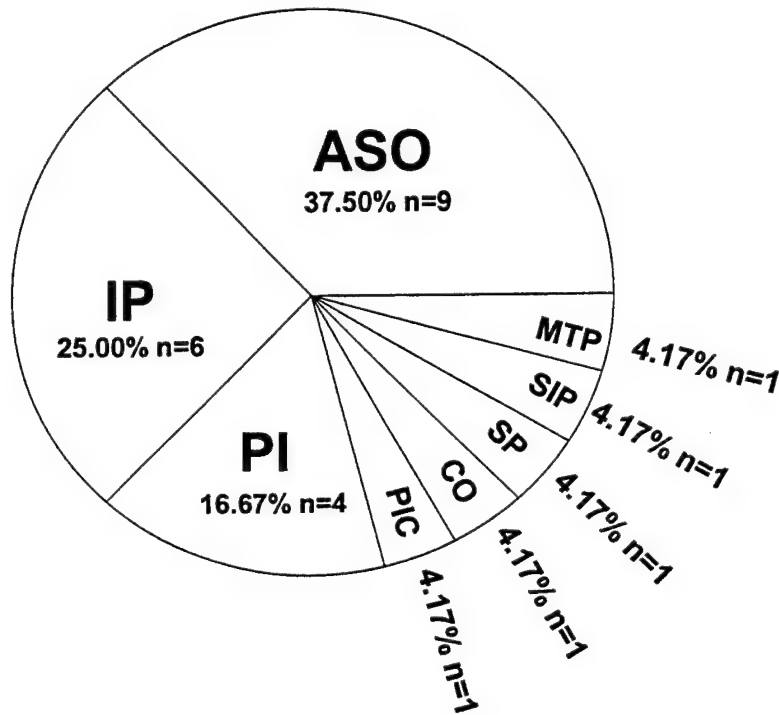


Figure 5. Position/jobs distribution. IP=instructor pilot, ASO=aviation safety officer, MTP=maintenance test pilot, SIP=standardization instructor pilot, SP=student pilot, CO=aviation company commander, PIC=pilot-in-command, and PI=line pilot.

Flight Activity Categories (FACs) and Readiness Levels (RLs)

FACs (1,2,3) are designated by an aviation unit commander based on the proficiency required by a particular aviator in a specific job or position. FAC levels are significant in that they mandate minimum semiannual aircraft and annual simulator hourly requirements for an aviator. RLs (1,2,3) are the levels of an aviator's proficiency to perform the unit's mission. An RL1 aviator is ready to perform a combat mission, whereas an RL3 has yet to demonstrate proficiency in basic flight tasks. Table 2 shows the distribution of FACs and RLs of the 24 subjects.

Table 2.
Distribution of FAC and RL.

	1	2	3	N/A*
FAC	1 (4.2%)	12 (50.0%)	4 (16.7%)	7 (29.2%)
RL	10 (41.7%)	1 (4.2%)	2 (8.3%)	11 (45.8%)

* FAC and RL do not apply to Department of the Army Civilian pilots.

Aviation experience

Total flight hours and simulated IMC flight experience are presented in Figures 6 and 7, respectively. Total aircraft flight hours are usually reflective of an aviator's level of maturity, responsibility, and ability. The total simulated IMC hours is indicative of prior experience using PVRDs.

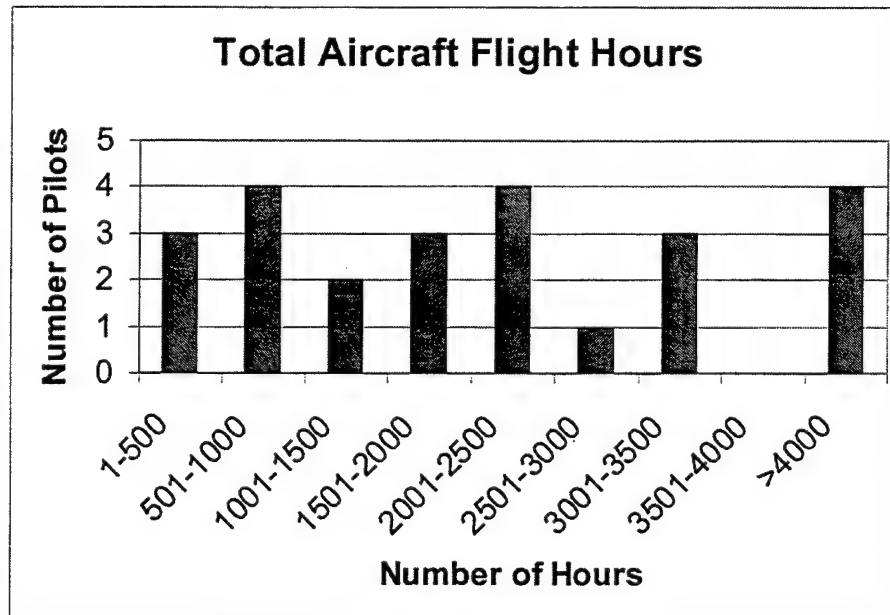


Figure 6. Total aircraft flight hours.

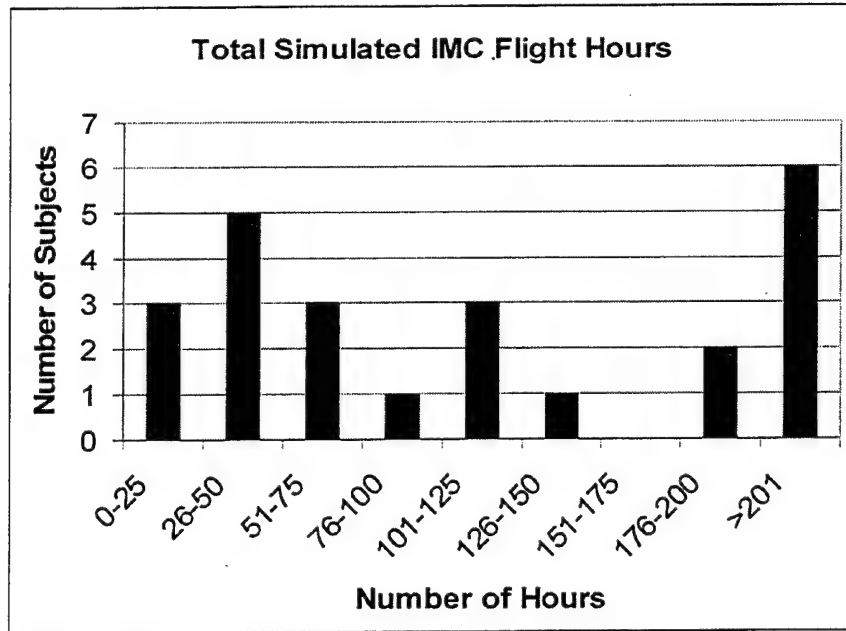


Figure 7. Total simulated IMC flight hours.

Current aircraft type

Figure 8 illustrates the type of aircraft in which the participants were flying in their current positions/jobs. The TH67 is used for primary instrument training. UH1 and UH60 pilots (flying “utility” helicopters) are generally more likely to perform instrument training and use PVRDs than those pilots whose current aircraft are observation or attack helicopters. Observation and attack helicopters have a predominately tactical mission and rarely train with PVRDs.

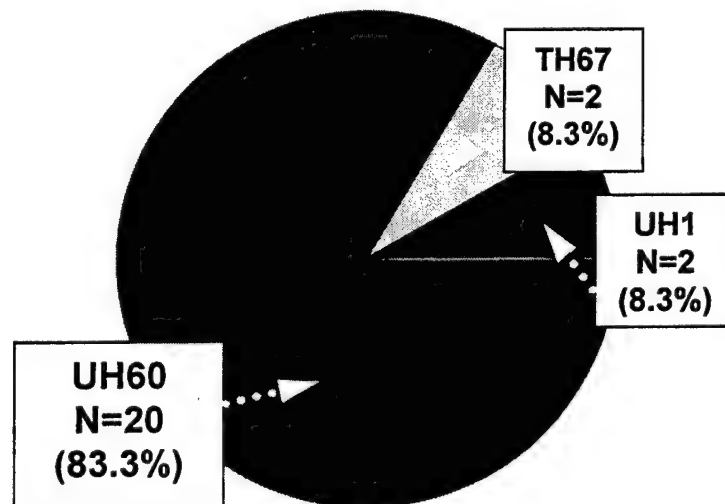


Figure 8. Participant aircraft types.

Postflight questionnaire results

Following each of the four instrument flights, participants were asked to assess each PVRD based on their perceptions of the device's performance as an aid to instrument training and to report any adverse physiological effects experienced during the flight while using the device. Following the fourth and final flight, the aviator rated the four PVRDs in order of preference.

Individual PVRD performance ratings

The following data were obtained as a result of the question, "How would you rate this device in regard to the following: field of view (answer), comfort during flight (answer), size (answer), ease of use and application (answer)?" Answer choices were: unsatisfactory, poor, fair, good, or excellent (Figure 9). Following their answers regarding these four characteristics, subjects were asked to add any comments (see participant comments regarding each PVRD below).

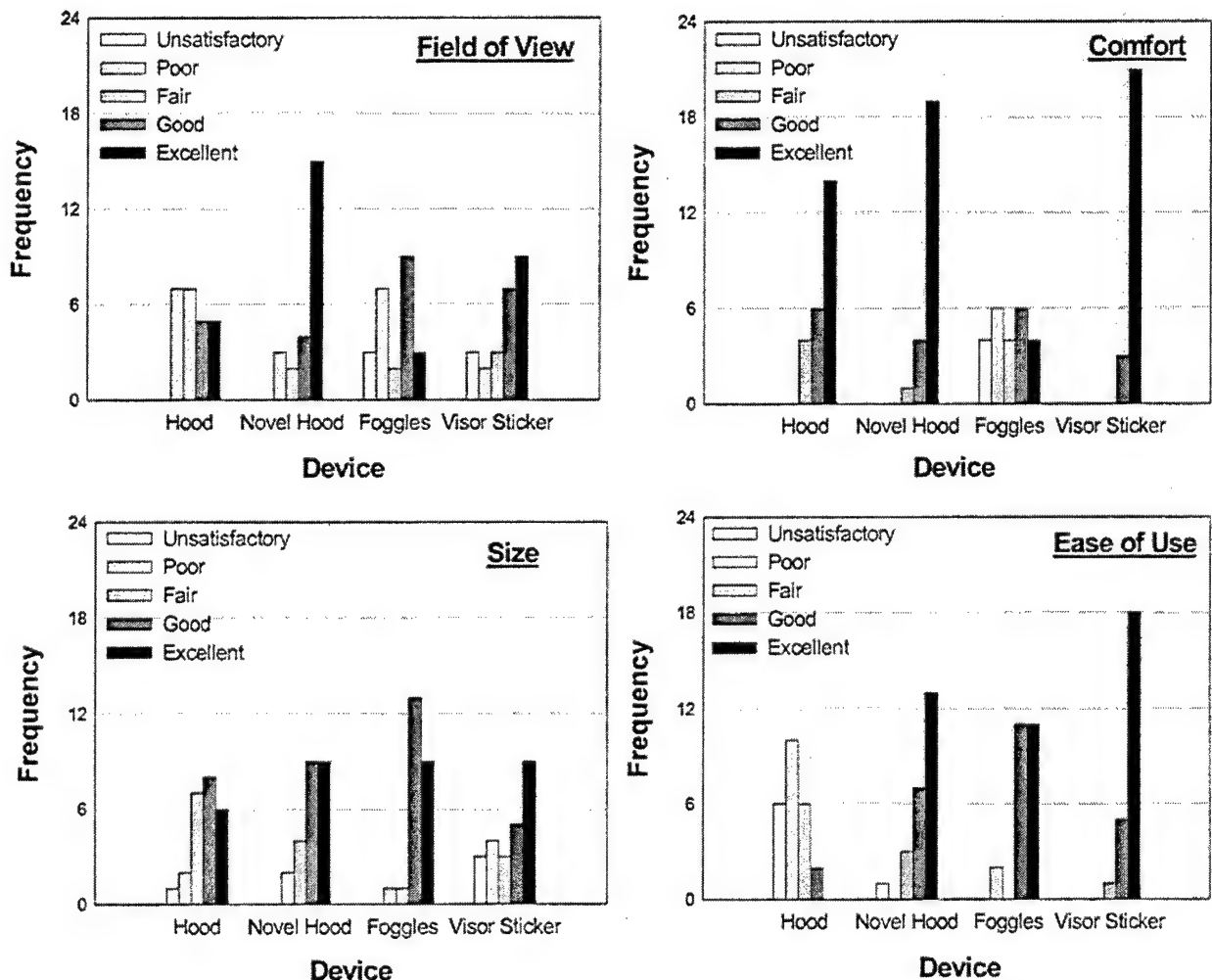


Figure 9. PVRD performance ratings.

Participant comments regarding each PVRD

The following comments were made in response to the investigator asking, "Are there any other comments regarding this device that you wish to add?" The question was asked immediately after completion of each segment of the postflight questionnaire.

Hood

- "Turning your head blocks the flight instruments."
- "Uncomfortable head position. Forces my head position downward to exclude the outside scene."
- "Difficult to put on."
- "Not bulky. Not heavy. Nice size to carry. Right shape."
- "Not effective."
- "Concentration [on] flight instruments, excellent."
- "Field of view needs to be more restrictive."

Visor sticker

- "Easy to use over and over by leaving in place. Can be left on visor and lifted for landings."
- "Can see outside of the cockpit, over the [cockpit] glare shield. Then when [visor] is lowered, [the visor sticker] allowed viewing over the device."
- "Doesn't block enough of [the] visual scene. [I] can see over the top of the device."
- "Too easy to see outside."
- "[I] see too much."
- "Did not cover enough of visor."
- "Field of view too great."
- "Could see what [my copilot] is doing. [I] can see too much, too much information."
- "[It needs to be] wider."
- "Doesn't effectively restrict vision."
- "[The use of this device] depends on [a] working [helmet] visor."
- "[A] sandy environment may affect effective use."
- "Too much field of view." (Recorded 2 times.)
- "Field of view [is] too large."
- "Too thin [narrow]."

Foggles®

- "My head position [is tilted rearward, which] caused my neck to hurt and the [temple of the] Foggles® break the helmet's ear seal."
- "[Their use] forces me to focus on the flight instruments."
- "Definitely made for instruments [training]."
- "[It] causes excessive head-tilt [rearward]. I didn't like it. It bothered my ears, [the] side of [my] head."

- “[Puts] pressure on [my] temples.”
- “Arms of the glasses [(temples)] cause a lot of discomfort, pressure. Easy to carry with you. Not bulky. Would get (Could cause) claustrophobia if not used to glasses.”
- “[Easy to] slide in and out. Caused hotspot [(discomfort)].”
- “[Cause] Pain.”
- “Hinders corrective glasses.”
- “Interferes with helmet.”
- “Requires unnatural head-tilt (back) during takeoff. Difficult to fit while wearing helmet.”
- “Breaks ear cup seal. [Causes] Abnormal head-tilt back for proper instrument scan. Field of view restricts too much.”
- “[They] might bother some people, the ear cups and Foggles® legs.”

Novel Hood

- “Forces head position downward to exclude outside scene. Uncomfortable head position.”
- “Can see above [the] device.”
- “Can see above it.”
- “Can see over the hood. [I] Want a small lip, I think, so [the] device doesn’t break if [the NVG visor adjustment] is put up.”
- “Can see over the top.”
- “Not effective as a hood.”
- “Secure [the] flap. Can see above hood.”
- “Lightweight. I like the flaps and the field of view.”
- “I like the flap.”
- “I love the flap.”
- “Too much field of view. Novel mod[ification] is positive improvement. I can see the CDU [(central display unit)].

Reports of adverse physiological experiences

The following data (presented in Table 3) were obtained as a result of the question, “Did you experience any of the following while using this device: uneasiness (answer), distraction (answer), despair (answer), claustrophobia (answer), nausea (answer), loss of situational awareness (answer), and spatial disorientation (answer)?” Answer choices were: none experienced, minimal, moderate, considerable, and severe. Subjects were asked if they had experienced any other effect not listed. None were reported.

Table 3.
Frequency of reported adverse physiological experiences.

Physiological Effects	Degree of Effect	Hood	Foggles®	Visor Sticker	Novel Hood
Uneasiness	None	23	18	22	23
	Minimal	1	3	2	1
	Moderate	-	3	-	-
	Considerable	-	-	-	-
	Severe	-	-	-	-
Distraction	None	17	11	19	17
	Minimal	5	3	3	2
	Moderate	1	6	2	5
	Considerable	1	4	-	-
	Severe	-	-	-	-
Despair	None	24	22	23	24
	Minimal	-	1	1	-
	Moderate	-	-	-	-
	Considerable	-	1	-	-
	Severe	-	-	-	-
Claustrophobia	None	24	23	24	24
	Minimal	-	1	-	-
	Moderate	-	-	-	-
	Considerable	-	-	-	-
	Severe	-	-	-	-
Nausea	None	24	23	24	24
	Minimal	-	1	-	-
	Moderate	-	-	-	-
	Considerable	-	-	-	-
	Severe	-	-	-	-
Loss of Situational Awareness	None	20	20	24	24
	Minimal	2	2	-	-
	Moderate	2	1	-	-
	Considerable	-	-	-	-
	Severe	-	1	-	-
Spatial Disorientation	None	23	22	24	24
	Minimal	1	1	-	-
	Moderate	-	1	-	-
	Considerable	-	-	-	-
	Severe	-	-	-	-

Order of preference

Following the assessments of individual PVRDs, the participants were asked to rate the PVRDs in order of preference. Specifically, they were asked, "If these four devices were on a table and you were headed out to fly, which device would be your first choice for use? Which would be your second choice? Third choice? Last choice?" The following table (Table 4) displays the frequency in which each PVRD was selected in order of preference.

Table 4.
PVRD order of preference.

Type of PVRD	Order of Preference (frequency)				Total
	1 st Choice	2 nd Choice	3 rd Choice	4 th Choice	
Hood	3	6	7	8	24
Visor sticker	4	8	5	7	24
Foggles®	5	5	6	8	24
Novel Hood	12	5	6	1	24

Discussion

Demographics

All participants were volunteers who responded to a solicitation by the principal investigator for subjects in the Fort Rucker (Alabama) area. To participate in the study, the volunteer could be an aviator (including student pilots) in any type of Army aircraft, since no aircraft-specific skills were required.

The results of the demographic survey indicate that a satisfactory distribution of pilots holding different jobs and/or positions was achieved in the study. The results indicate that 37.5% of the sample population were aviation safety officers while 29.2% were instructor pilots (IPs and SIPs). These two job positions are characterized by, and generally filled with, experienced aviators, an important source of information concerning current operational conditions in the field.

The population's total aircraft and simulated IMC flight hours' range of distribution provided important perspective: input from those who fly and are trained while wearing a PVRD and from those who use a PVRD as an aid to train other pilots.

A secondary purpose of the demographic survey was to try to examine whether there were any relationships between the demographic categories (positions/jobs, FACs/RLs, aviation experience and aircraft type) and PVRD preference. Table 5 presents the results of statistical tests conducted to determine if any significant relationships existed between demographic variables and their PVRD preferences. The only relationship of statistical significance ($\alpha = 0.05$), and a fairly strong one based on Cramer's V and Contingency Coefficient test values, is that of jobs and a preference for the Novel Hood. The data indicate that 71% of instructor pilots and 55% of the aviation safety officers chose the Novel Hood as their first choice. This is important as these jobs are performed by experienced aviators with insights into training effectiveness and aviation safety, thus, lending a level of credibility to the idea of the Novel Hood.

Table 5.
Crosstabulation results.

Demo- graphic Variable	PVRD Order of Preference	Pearson Chi-Square	df	Symmetric Measures		Approximate and Asymptotic Significance (2-sided)*
				Cramer's V	Contingency Coefficient	
Jobs	Hood	29.833	21	.644	.744	.095
	Novel Hood	37.422	21	.721	.781	.015**
	Foggles®	23.528	21	.572	.704	.316
	Visor Sticker	21.271	21	.544	.685	.442
Flight Activity Category	Hood	10.265	9	.378	.547	.329
	Novel Hood	11.414	9	.398	.568	.248
	Foggles®	7.314	9	.319	.483	.604
	Visor Sticker	4.644	9	.254	.404	.864
Readiness Level	Hood	12.018	9	.409	.578	.212
	Novel Hood	6.538	9	.301	.463	.685
	Foggles®	10.778	9	.387	.557	.291
	Visor Sticker	7.047	9	.313	.476	.632
Total Flight Hours	Hood	22.179	21	.555	.693	.389
	Novel Hood	25.267	21	.592	.716	.236
	Foggles®	23.367	21	.570	.702	.325
	Visor Sticker	25.679	21	.597	.719	.219
Total Simulator Hours	Hood	22.167	21	.555	.693	.390
	Novel Hood	21.240	21	.543	.685	.444
	Foggles®	26.527	21	.607	.725	.187
	Visor Sticker	20.874	21	.538	.682	.467
Type Aircraft	Hood	6.593	6	.371	.464	.360
	Novel Hood	2.440	6	.225	.304	.875
	Foggles®	6.690	6	.373	.467	.350
	Visor Sticker	4.740	6	.314	.406	.578

* Asymptotic significance from Pearson Chi-Square test.

** Significant at the 0.05 level.

Flight results

Individual PVRD performance ratings

Based on the ratings provided by the participants, the following highlights regarding the four characteristics of PVRD performance are presented.

Field of view

It should be noted that the Novel Hood produced 15 excellent ratings regarding its field of view compared with nine for the visor sticker, five for the hood, and three for the Foggles®. This is no doubt the result of the modified "wings" which allow greater visibility of the cockpit area while still restricting outside visual reference. Also noteworthy is that the Foggles® and the visor sticker were the only two devices receiving unsatisfactory ratings with each receiving three. The Foggles® produced the greatest number (10) of total poor to unsatisfactory ratings.

Comfort during flight

Regarding the devices' comfort during flight, the visor sticker received 21 excellent ratings. The Novel Hood came in second with 19 and the hood received 14. The Foggles® received the only unsatisfactory ratings (four). The researchers attribute these findings of comfort to the apparent effect of the device on the ordinary wear and relative comfort of the flight helmet. The visor sticker, which does not contact the face and adds no weight, is logically more comfortable than either of the hoods, which add weight to the head; and the Foggles®, which cause pressure to the bridge of the nose and temple areas of the head.

Size

The devices' size was considered as an aspect of performance in that its size contributes to its adequacy as an effective aid to instrument training. The Foggles® received the greatest number of good to excellent ratings while the visor sticker received the most (by far) fair to unsatisfactory ratings. The hood was the only other device to receive an unsatisfactory rating (one).

It must be noted that the rating of size could indicate that the device was too large or too small. Additional questions regarding this quality might have provided additional insight. Based on participant comments, however, the perception of the researchers is that unfavorable ratings of the visor sticker was due to its size being too small while unfavorable ratings of the hood was due to its size being too large.

Ease of use/application

A glance at the "Ease of Use" chart in Figure 9 provides a clear picture that the visor sticker was considered the easiest to don and use. The hood was rated the poorest performer with six unsatisfactory, ten poor, and six fair ratings. This was obviously due to the difficulty in donning

the hood while still wearing the flight helmet. Several participants were unable to mount the hood without the assistance of either their copilot or a researcher. The Novel Hood and Foggles® both received generally favorable ratings.

Performance summary

In order to more easily compare PVRD performance characteristics, each rating was assigned a point value (unsatisfactory = 1, poor = 2, fair = 3, good = 4, and excellent = 5). Using this scheme, an "excellent" rating by all 24 (the number of subjects) results in a perfect score of 120 (5x24). Table 5 presents a comparison of the PVRD characteristics ratings score out of a possible 120 points, and thus provides a performance summary.

Table 6.
PVRD performance summary.

	Hood	Visor Sticker	Foggles®	Novel Hood
Field of view	80	89	74	103
Comfort during flight	106	117	72	114
Size	88	85	102	97
Ease of use/application	52	113	103	103
Overall Performance Possible Total = 480	326	404	351	417

Reports of adverse physiological experiences

Interestingly, all of the adverse physiological effects that were reported by those who participated in the user survey (Appendix B) were experienced by at least one of the volunteers of the PVRD study.

The Foggles® produced the greatest number and diversity of adverse effects with 27 complaints and with at least one account of each listed effect. The device was particularly notable for producing six reports of uneasiness and 13 reports of distraction, four of which were rated as considerable. The Foggles® were the only device to have produced an effect rated as severe (loss of situational awareness) and caused two accounts of spatial disorientation (one minimal and one moderate).

The hood produced 13 such adverse effects. It was reported to have caused uneasiness (one minimal account), distraction (seven; one up to the considerable level), loss of situational awareness (four; two at moderate level) and spatial disorientation (1 minimal).

The visor sticker and Novel Hood each reportedly produced 8 adverse effects. Each produced minimal conditions of uneasiness and up to moderate levels of distraction.

Order of preference

According to the data presented in Table 4, the Novel Hood was the first choice of 12 (50%) of the participants, the Foggles® were second with five first choices followed by the visor sticker with four and the hood with three. The Novel Hood was the fourth choice once, the visor sticker seven times, followed by the Foggles® and hood with eight fourth choice picks apiece.

Participant comments

The researchers attempted to discover a consensus, multiple themes or central issues, among the additional comments made regarding each PVRD. Regarding the hood, the comments were diverse with no central issue.

The comments did, however, indicate that there was a general dissatisfaction with the lack of visual restriction of the visor sticker. The field of view was too large allowing the viewing of too much of the outside visual scene.

The Foggles® were generally criticized for requiring the pilot to maintain an unnatural rearward head-tilt in order to view the flight instruments and for causing pain/discomfort in the temple area of the head.

Initially, the Novel Hood was disparaged for the need to position the head downward in order to keep from seeing over the top of the device. It was later determined, during the data collection of Subject 12, that previous subjects had not adjusted their NVG mount to the full upright position. Modifications to the Novel Hood fitting procedures eliminated this problem in subsequent subjects. Due to the transient nature of the sample population (Army pilots stationed around the world), it was not possible to locate and retest subjects 1 – 11 regarding their impressions of the Novel Hood. It is worthy to note that only one of the first 11 participants rated the Novel Hood as their first choice, but, after revising the fitting procedures, 11 of the remaining 13 participants rated it as their first choice (Table 7).

Table 7.
Novel Hood preferences by subject groups

Novel Hood	Order of Preference (frequency)				Total
	1 st Choice	2 nd Choice	3 rd Choice	4 th Choice	
Subjects 1 - 11	1	4	6	0	11
Subjects 12 - 24	11	1	0	1	13

Investigator observations

In addition to the collection of the above data, the investigators made several observations that may be useful.

1. The Gentex hood, which is made of plastic and snaps onto the aviator helmet (Figure 1, center picture), is held in place on the sides with two "wings." In order to apply the hood to the helmet, the wings are spread to snap behind the helmet's visor track. Midway through the study (after about 12 uses), the hood developed a crack at each corner (Figure 10). The hood remained functional throughout the study but the cracks raised questions as to its durability in the field where it would be exposed to repeated use.

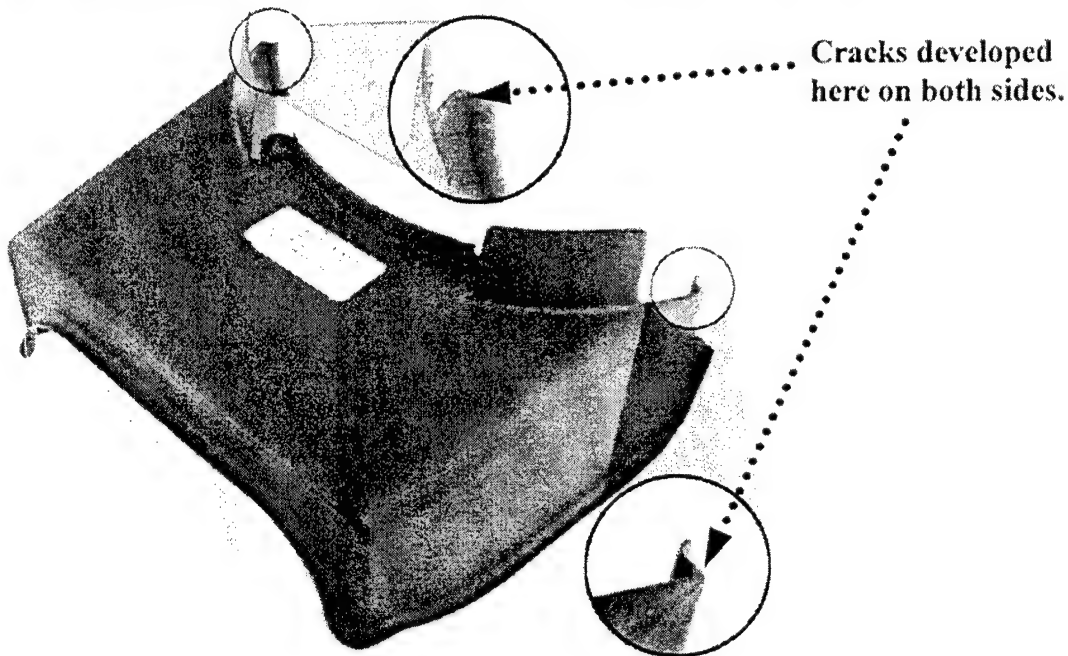


Figure 10. Points at which cracks developed.

2. The Gentex hood was the only device which frequently could not be donned by the participant without the aid of his/her copilot or the investigator.
3. The visor sticker used for the study was "The Cloud" (Wings Aviation Products, Appendix H). The Cloud provides approximately one-inch of visual restriction across the visor (it is about one-inch wide from top to bottom) (Figure 11). During the study, several participants commented as to the need for a greater visual restriction. At some

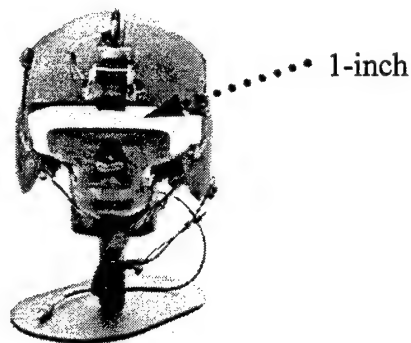


Figure 11. Visor sticker

point during the last one-third of the data collection flights, the investigators became aware, through discussions with the participants, that a wider visor sticker (approximately 2-inches wide from top to bottom) was available (SSI, Incorporated, Appendix H). In order to maintain study continuity and consistency, the investigator completed the study with the original one-inch visor. Therefore, the visor sticker assessments reported in this report are based on the one-inch version.

4. The visor sticker adheres to the visor the same way polyethylene wrap (cling wrap) adheres to dishware. The investigator noted that after several uses the visor sticker became soiled from dust, dirty visors, and dirt and oils from the participants' hands. This resulted in the loss of much of its adhesiveness. A household cleanser, however, restored its adhesive qualities. This point is made because it raises questions as to how useful this type of device would be in a dusty, desert environment without frequent cleaning.

Conclusions

This study attempted to identify the most preferred PVRD among three devices reportedly used by a survey population and a newly designed hood concept. When considering all of the data in aggregate, the Novel Hood was judged the most preferred based on performance ratings, minimal reports of adverse affects, and its selection as the first choice of one-half of the participants.

The most preferred device among those readily available for use by aviators appears to be the visor sticker. The device received the "best" ratings in comfort and ease of use/application and second place in field of view. As addressed above in Investigator Observations, its "worst" rating in size appears to be attributable to the 1-inch model used in this study. The 2-inch model should rectify this reported deficiency. Its minimal reports of adverse effects are comparable to that of the Novel Hood. Its cost of \$2.99 per device adds to its favorability and is therefore the best current choice for use during instrument training.

The Foggles® received "worst" ratings in both the field of view and comfort categories. Additionally, the Foggles® produced a noteworthy number of adverse effects including four reports of considerable distraction. Selected as the fourth choice by one-third of the participants and at the cost of \$24.95 each, the Foggles® performance may not justify its cost.

The hood was easily identifiable as the least favored. It received generally poor performance appraisals and caused a relatively sizeable number of reported adverse effects, including loss of situational awareness and spatial disorientation. It was selected by the participants as their third or fourth choices 15 out of 24 times. At a cost per unit of \$52.40, it is hard to justify its continued use.

As stated, the purpose of this study was to elicit user comments regarding the suitability of various PVRDs as adjuncts to instrument flight training. It is assumed that any device that deprives the user of outside visual cues will ensure reliance, and therefore training, on cockpit instruments and displays. Since it appears likely that the most current versions of these four devices, when properly worn, achieve this objective, the participant comments regarding "human factors" provided in this study are highly relevant. Nonetheless, it is possible that reports of degraded situational awareness and increased spatial disorientation may actually reflect more effective sensory deprivation and poorer instrument flying skills. Despite these concerns about specific situational awareness-related findings of the study, the user comments and strong preference for the Novel Hood are persuasive.

Recommendations

Based on the findings of this study, the researchers are pursuing a patent for the Novel Hood. Its overall favorable ratings indicate its acceptability to the aviation community and its demonstrated promise of minimizing the adverse effects associated with PVRD use during instrument flight training.

The researchers recommend that the U.S. Army issue the visor sticker as an interim "standard" for meeting the conditions set forth in all aircrew training manuals. Continued allowance of the use of varied, nonstandardized devices may actually serve to detract from and/or impair training.

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Appendix A.
User Survey.

**United States Army Aeromedical Research Laboratory
Fort Rucker, Alabama**

User Survey

This survey is anonymous. The information collected will help determine if the hoods, Foggles[®], and other peripheral vision-restricting devices currently available and in use are satisfactory or if there is a need to develop a standard device for use by the U.S. Army.

Please circle the responses that most accurately answer the following questions.

1. How often do you use a peripheral vision-restricting device to train for instrument flight?

neverweekly biweekly monthly quarterly semiannually
annually Other (be specific) _____

2. What device do you normally use, if and when you use one? (List manufacturer or National Stock Number, if possible.)

3. Is there a device that you would prefer to use, if and when you use one? (List manufacturer or National Stock Number, if possible.)

4. Do you feel that a peripheral vision-restricting device is important to instrument training and proficiency?

Y N Explain, if necessary _____

5. Do you feel that a peripheral vision-restricting device should be standardized for Army issuance and use?

Y N Explain, if necessary _____

6. Have you ever experienced any of the following negative effects while wearing a peripheral vision-restricting device? (Circle all that apply.)

Uneasiness Despair Distraction Nausea Claustrophobia

Loss of Situational Awareness Spatial Disorientation No Negative Effects

Other _____

7. How often have you experienced the above negative effects?

N/A Each Time Occasionally Frequently Rarely

*****PLEASE PROVIDE ANY ADDITIONAL COMMENTS ON BACK OF THIS FORM*****

Appendix B.
User Survey results.
PVRD survey results (Abbreviated)

1. How often do you use a peripheral vision-restricting device to train for instrument flight?

Never	Weekly	Biweekly	Monthly	Quarterly	Semiannually	Annually	Daily	Misc
6	29	5	10	6	6	8	45	6
5%	24%	4%	8%	5%	5%	7%	37%	5%

2. What device do you normally use, if and when you use one? *

Hood w/NVG mount	Hood w/o mount	DA 2408-12/-13	Visor sticker	Foggle	Jeppeson Flip-up	Did not answer
19	7	6	74	5	1	15
16%	6%	5%	61%	4%	1%	12%

3. Is there a device that you would prefer to use, if and when you use one?

Hood w/NVG mount	Hood w/o mount	Visor sticker	Foggle	No Preference	Did not answer
8	2	22	5	41	43
7%	1%	18%	4%	34%	36%

4. Do you feel that a peripheral vision-restricting device is important to instrument training and proficiency?

Yes	No
95	26
79%	21%

5. Do you feel that a peripheral vision-restricting device should be standardized for Army issuance and use?

Yes	No	Did not answer
81	35	5
67%	29%	4%

6. Have you ever experienced any of the following negative effects while wearing a peripheral vision-restricting device? *

Uneasiness	Despair	Distraction	Nausea	Claustrophobia	Loss of Situational Awareness	Spatial Disorientation	Miscellaneous Negative Effects	No Negative Effects	Did not answer
18	6	10	7	9	16	35	9	48	11
15%	5%	8%	6%	7%	13%	29%	7%	40%	9%

7. How often have you experienced the above negative effects?

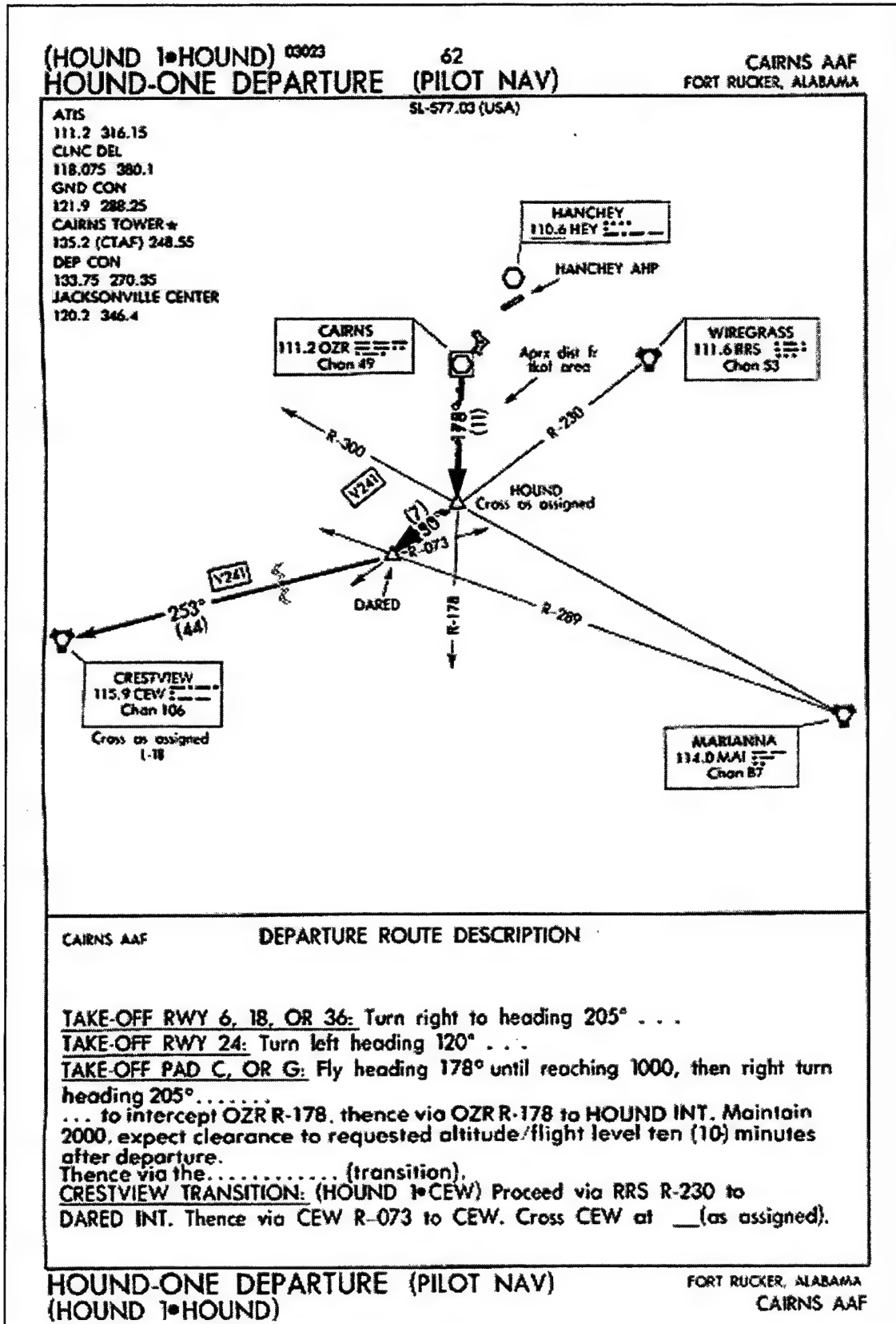
Not applicable	Each time	Occasionally	Frequently	Rarely	Did not answer
55	5	21	3	35	2
45%	4%	18%	2%	29%	2%

* Respondents selected more than one answer.

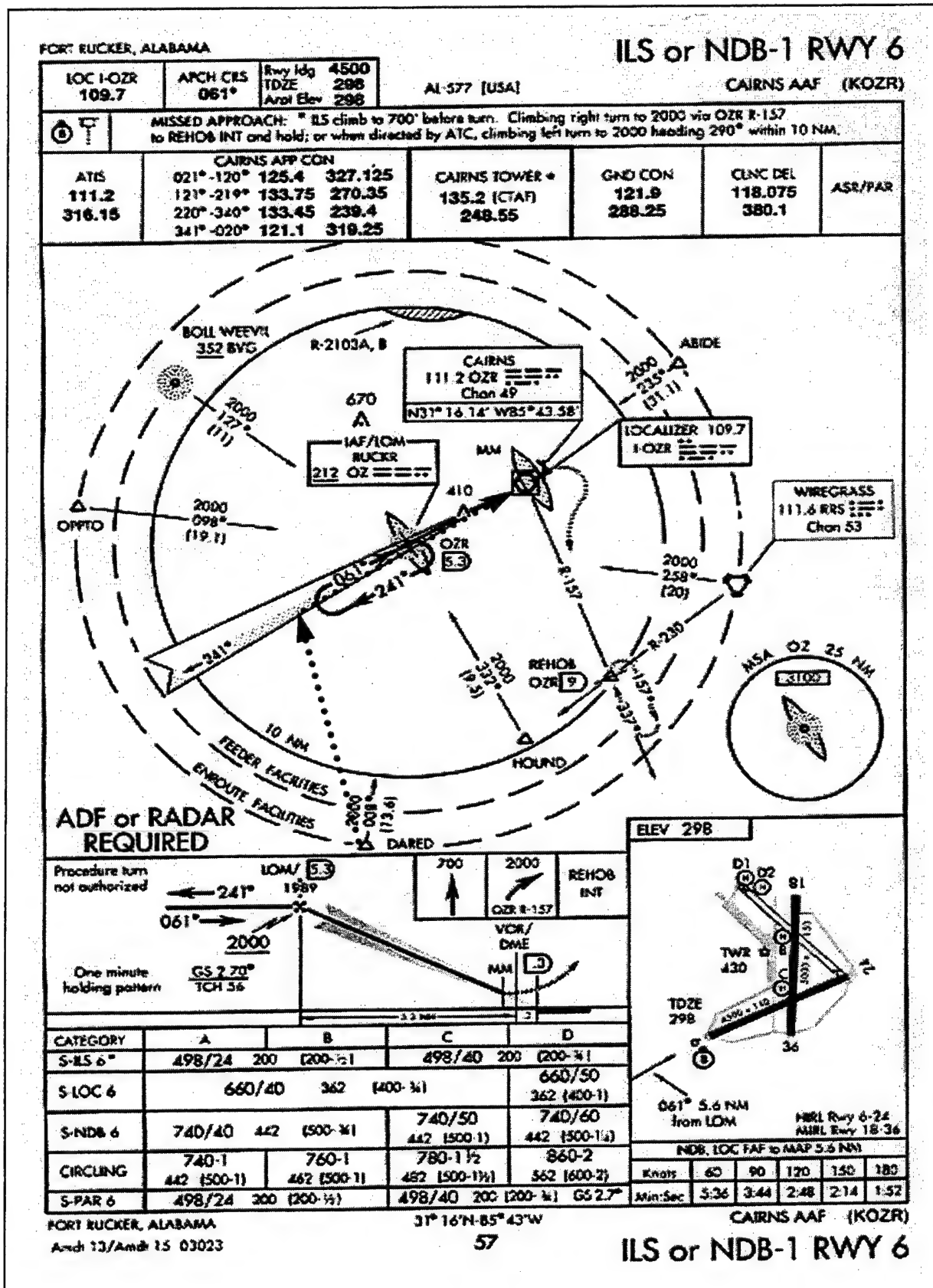
Appendix C.

Research flight profiles.

Research Flight Profile at Cairns Army Airfield (Page 1 of 2)



Research Flight Profile at Cairns Army Airfield (Page 2 of 2)
Research Flight Profile at Campbell Army Airfield



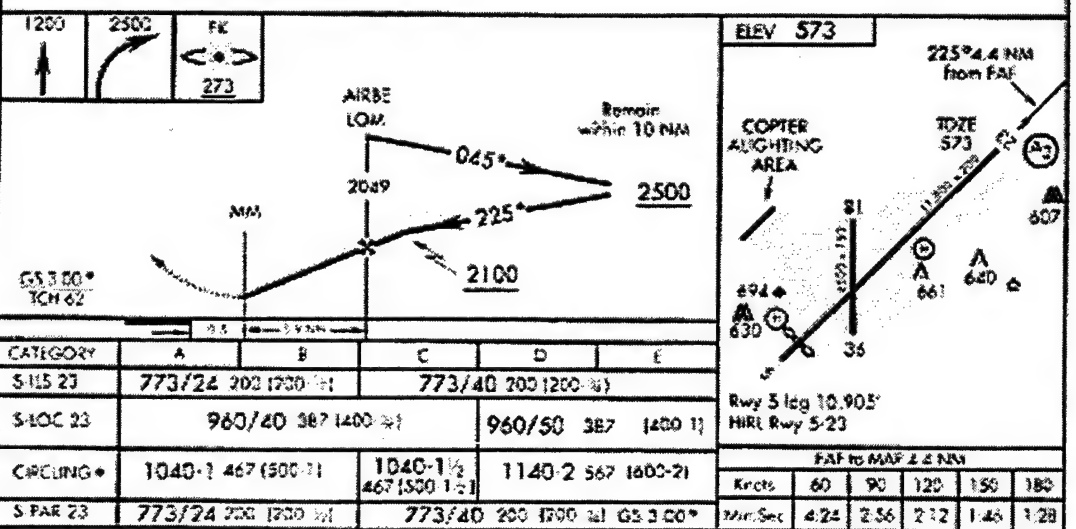
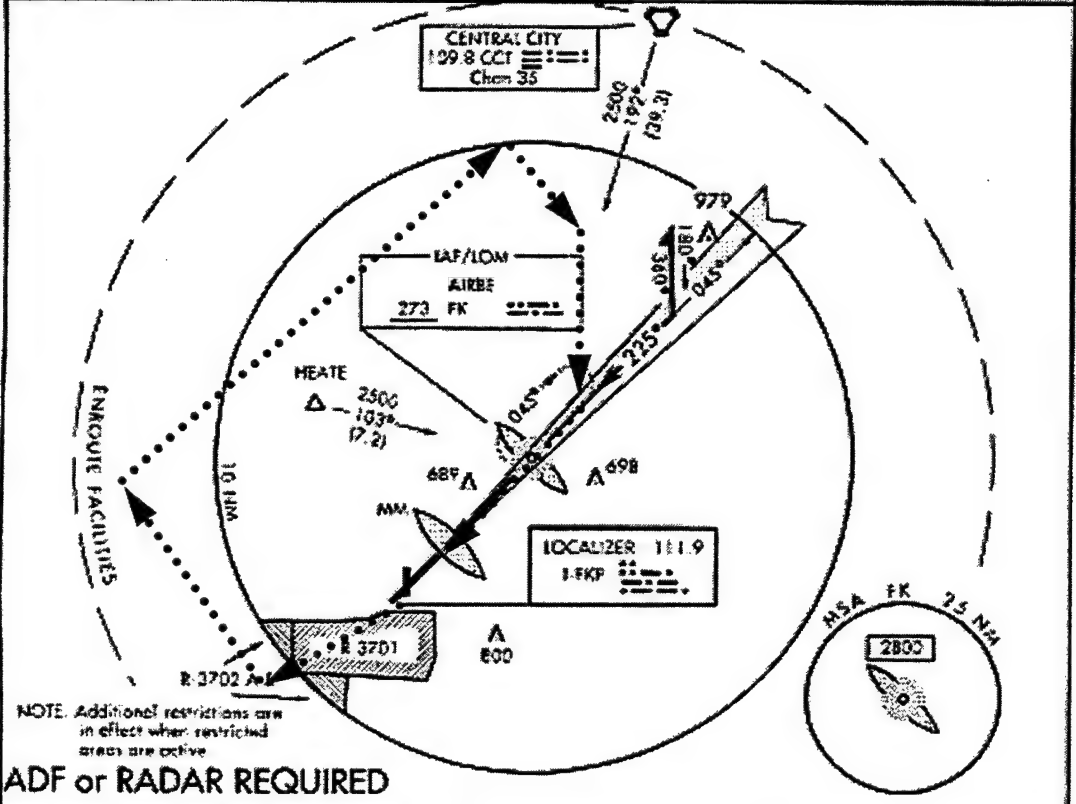
FORT CAMPBELL, KENTUCKY

ILS RWY 23

LOC I-FKP 111.9	APCH CRS 225°	Rwy ldg 11,800 TDZE 573 Appl Elev 573	AL-679 [USA]	CAMPBELL AAF (KHOP)
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CATE procedure turn not authorized. Radar required. *Circling not authorized SE Rwy 5-23.	SALS (A) 3	MISSED APPROACH: Climb to 1200 then climbing right turn to 2500 direct to FK LOM and hold.
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ATIS 125.175 308.4	CAMPBELL APP CON 118.1 269.525	CAMPBELL TOWER 120.9 278.8	GND CON 121.8 265.8	CINC DEL 138.8	ASR/PAR
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FORT CAMPBELL, KENTUCKY

Amr 10 04106

35

34°45'N 87°30'W

CAMPBELL AAF (KHOP)

ILS RWY 23

Appendix D.
Permission briefing.

PREMISSION BRIEFING:

You have volunteered to participate in a research project whose objective it is to examine peripheral vision restricting devices (PVRD). You will fly four individual flights under instrument meteorological conditions while wearing a different PVRD for each flight.

Each flight will consist of an instrument takeoff, cruise flight and terminate with an ILS (Instrument Landing System) approach. The route of flight will be as follows: Hound-One Departure from Cairns Army Airfield to Dared intersection, followed by vectors to intercept the ILS Runway 6 approach, full stop to Cairns.

Simulated weather for the entire area is forecast, ETA through one hour, to be winds calm; 7sm visibility; ceilings are overcast at 3000 feet with cloud tops at 10000 feet; altimeter setting 2992.

Any questions?

Appendix E.
Post flight questionnaire.

United States Army Aeromedical Research Laboratory
Fort Rucker, Alabama
Peripheral Vision Restricting Device Postflight Questionnaire

SUBJECT # _____

FLIGHT #: 1 2 3 4

Please circle the responses that most accurately answer the following questions.

1. What device was used during this flight?

Hood w/NVG mount Novel hood Foggles Visor Sticker

2. How would you rate this device in regard to the following: (Check 1 block per line)

	Unsatisfactory	Poor	Fair	Good	Excellent
Field of View					
Comfort during Flight					
Size					
Ease of Use/Application					
Other:					
Other:					

3. Did you experience any of the following while using this device? (Check 1 block per line)

	None Experienced	Minimal	Moderate	Considerable	Severe
Uneasiness					
Distraction					
Despair					
Claustrophobia					
Nausea					
Loss of Situational Awareness					
Spatial Disorientation					
Other:					
Other:					

STOP. Continue only after the fourth and final flight.

Please rate the devices in order of preference "1" to "4" ("1" being the best):

_____ Hood w/NVG mount
_____ Novel hood
_____ Foggles
_____ Visor Sticker

Appendix F.
Demographic questionnaire.

A Comparison Study of Peripheral Vision-Restricting Devices (PVRD) used for Instrument Training

DEMOGRAPHIC QUESTIONNAIRE Subject # _____

Please circle the responses that most accurately answer the following questions.

4. What term best describes your current position or job title?

Student Pilot Line Pilot (PI)
Pilot-in-Command (PC) Unit Trainer (UT)
Instrument Examiner (IE) Instructor Pilot (IP)
Standardization Instructor Pilot (SIP) Aviation Platoon Leader
Aviation Staff Officer (any level) Maintenance Test Pilot
Aviation Company Commander Aviation Battalion Commander or above

5. What is your current Flight Activity Category (FAC) designation?

1 2 NA

6. What is your current Readiness Level (RL)?

1 2 3 NA

7. How many total flight hours have you logged (exclude simulator)?

1-500 501-1000 1001-1500 1501-2000 2001-2500 2501-3000
3001-3500 3501-4000 4001 or greater

8. How many total simulated IMC hours (hood time) have you logged?

1-25 26-50 51-75 76-100 101-125 126-150
151-175 176-200 201 or greater

9. In what aircraft are you current? (List all if more than one type.)

Appendix G.
Details of relevant literature and research review process.

Review of relevant literature and research

An extensive search for relevant literature and research (including works in progress) included the exploration of DTIC (Defense Technical Information Center), NTIS (National Technical Information Service), MEDLINE (a service of the U.S. National Library of Medicine and the National Institutes of Health), and psychINFO (American Psychological Association) databases. The following keywords and constructs were used: instrument flight <and> accident or mishap (any variations); instrument flight <and> training; instrument flight <and> vision <and> (restriction <or> interference <or> restrictor <or> restrictors); aviation accidents <and> instrument flight; cockpit (any variations) <and> vision; cockpit (any variations) <and> inside; cockpit (any variations) <and> within; cockpit (any variations) <and> inside <and> within; instrument hood (any variations); and instrument hood (any variations) and vision. The searches produced no PVRD-related research or literature.

An additional search of the worldwide web using search engines Yahoo!, Google, and Dogpile; and the Federal Aviation Administration's accident summary files produced significant numbers of reports and articles regarding instrument flight and accidents; however, none had anything to do with the proposed research subject, PVRD usage, even indirectly. These searches, however, produced many advertisements for such devices for sale. The following keywords and constructs were used: instrument flight accidents; instrument flight training; instrument flight vision restrictors; cockpit vision restrictors; and instrument hoods.

Appendix H.
Manufacturer's List

The Foggles® (USPN 4698022)
Foggles® Incorporated
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Glossary

The following terms are defined for clarity and understanding:

Department of the Army Civilian (DAC): For the purposes of this report, civilian pilots employed by the Army as civil servants to operate aircraft and train Army aviators.

Line Pilot: A qualified aviator who is a current member of the active Army or National Guard/Reserve.

Flight Activity Categories (FAC): FACs (1,2,3) are designated by a commander based on the proficiency required by a particular aviator in a specific job or position. FAC levels are significant in that they mandate minimum semiannual aircraft and annual simulator hourly requirements for an aviator. FACs do not apply to DACs. (Department of the Army, 1996b)

IMC (instrument meteorological conditions): Meteorological conditions expressed in terms of visibility whereas reference to aircraft instruments is required to maintain the aircraft's attitude, position and/or track.

Readiness Levels (RL): RLs (1,2,3) are the levels of an aviator's proficiency to perform the unit's mission. An RL1 aviator is ready to perform a combat mission, whereas an RL3 has yet to demonstrate proficiency in basic flight tasks. RLs do not apply to DACs. (Department of the Army, 1996b)

USAARL: The United States Army Aeromedical Research Laboratory conducts research to prevent or minimize health hazards in the military operational environment and to sustain the aviator's individual performance.

VMC (visual meteorological conditions): Meteorological conditions expressed in terms of visibility whereas reference to aircraft instruments is not required to maintain the aircraft's attitude, position and/or track.